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NASA Human Factors Programmatic Overview

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INTRODUCTION

Human factors addresses humans in their active and interactive capacities, i.e., in the mental and physical activities they perform and in the contributions they make to achieving the goals of the mission. The overall goal of space human factors in NASA is to support the safety, productivity and reliability of both the on-board crew and the ground support staff. Safety and reliability are fundamental requirements that human factors shares with other disciplines, while productivity represents the defining contribution of the human factors discipline.

PROGRAMMATIC ORGANIZATION AND DIRECTION

Space Human Factors in NASA forms an essential component of two NASA HQ program offices, each with a complementary role to play. The Life Science Division of the Office of Space Science and Applications (OSSA) looks at human factors from a scientific perspective including connections with the biomedical sciences. The Life Science Division develops the human requirements that must be addressed in space-flight, including those associated with behavior and performance. The Information Science and Human Factors Division of the Office of Aeronautics, Exploration and Technology (OAET) is concerned with human factors as it relates to the design, development and implementation of technology products. Here, an understanding of humans' ability to use and benefit from facilities and tools is a necessary element of the technology research and development process.

Human Factors has a special relationship to the mission activities that must be performed, and Human Factors programs begin with discipline-oriented mission analyses. The general content of the OSSA program is given in Figure 1. This figure indicates the emphasis on basic understand-

ing of human requirements and capabilities as well as countermeasures to deal with human limitations or negative effects due to the space environment. Similar information for the OAET program is given in Figure 2, indicating an emphasis on crew station design and on human performance modeling, instrumentation for crew support, and integrated systems.

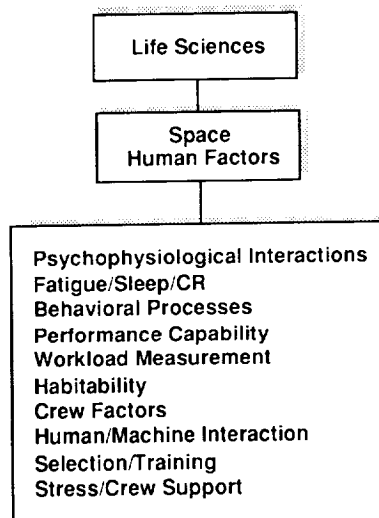


Figure 1 - OSSA Human Factors Emphases

Figure 2 also shows the OAET thrusts to which these human factors elements relate. Since human factors is a cross-cutting technology, the program impacts all thrust areas. However, human factors has a special relationship to Operations (where the actions of the human participants are central) and to Planetary Surface Explorations (where, because of distance, duration, and multiplicity of environments, the demands on human participants take on special importance).

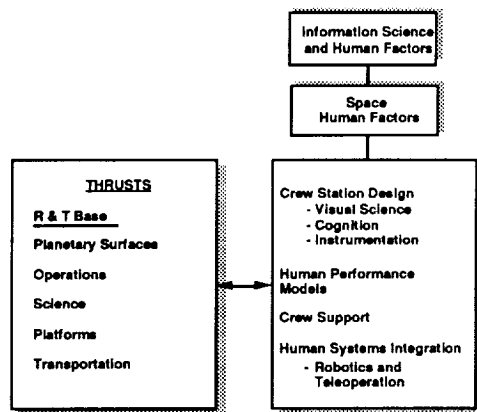


Figure 2 - OAET Human Factors Emphases

In addition to its own internal planning, NASA regularly seeks the advice of special panels to help the Agency identify important issues and needs. These panels are comprised of university, industry, and government specialists. One such panel is the Space Science and Technology Advisory Committee (SSTAC). Figure 3 presents an abbreviated description of areas recently identified by the Human Factors subcommittee of SSTAC as representing important and timely research undertakings. All of the areas identified by SSTAC are contained within the broad structure of the combined Agency space human factors program, and their announcement by this subcommittee serves both to confirm the approach being taken and to give greater specificity to the identified research needs and opportunities.

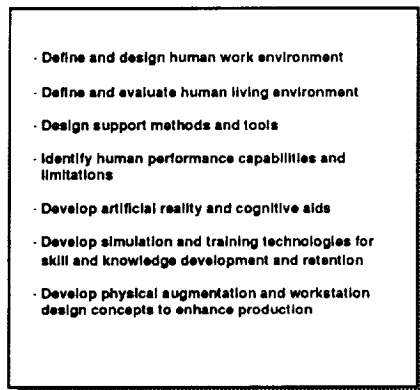


Figure 3 - High Priority Issues as Defined by SSTAC

FIELD CENTER EMPHASES

Research within NASA is conducted primarily by and through the field centers. Much of this research is conducted in-house, with a significant amount being conducted through university or other granting arrangements. Human factors activity can be found at all of the major NASA centers. However, most space human factors research and development is concentrated between two centers: Ames Research Center (ARC), Moffett Field, CA, and Johnson Space Center (JSC), Houston TX. Work at the two centers complements each other, both in the nature of the approach taken and in areas of special emphasis and expertise. At ARC, the tendency is towards more development-based research, allowing the building blocks of understanding to be established, the extent and limitations of results to be assessed, and the space application to be developed. At JSC, the tendency is towards more implementation-based research, making a close connection with particular flight needs, and utilizing the Center's access to space simulation facilities and to the astronaut corps. Neither center presents a pure model but reflects, rather, a tendency or general approach. Considerations that drive the emphases also influence the location of specialty areas within the human factors discipline.

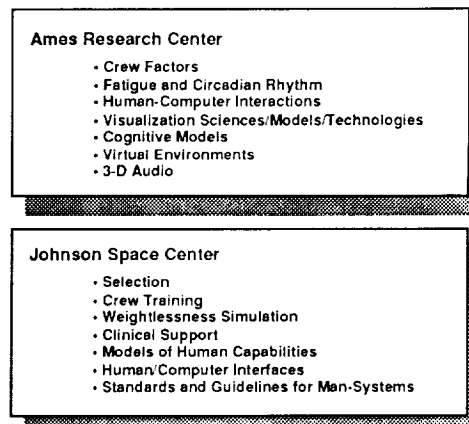


Figure 4 - Field Center Emphases

Human factors specialties for both ARC and JSC are given in Figure 4. At ARC, space research on crew fatigue and circadian rhythm as well as crew factors (crew communication and coordination) are natural outgrowths of ongoing aviation crew research, while in-house expertise in perceptual and cognitive sciences provide the

foundation for development of crew support tools such as virtual environments and 3-D audio displays. At JSC, Center responsibility for selection, training, and crew well-being translate into research to support these requirements and to the establishment of standards to guarantee them. Both centers are strongly involved in developing models to understand and design to human requirements, while both also emphasize the emerging and dominating importance of human/computer interactions. Laboratory facilities at each center, reflecting the research areas described, are listed in Figure 5.

ARC Labs	JSC Labs
Visual Science and Technology	Anthropometry and Biomechanics
Cognition	Human/Computer Interaction
Virtual Reality	Graphics Analysis
Crew Factors	Remote Operators Interaction
Circadian Factors and Countermeasures	Weightlessness Environment Test Facility
Aviation Simulators/Analog	Shuttle Simulation and Training Facility

Figure 5 - Facilities at ARC and JSC

FROM RESEARCH TO OPERATIONS

A ubiquitous problem for all research organizations involves transitioning research results for use by real people doing real jobs. This is a highly complex and dynamic undertaking that requires, at a minimum, establishing a partnership between two quite diverse communities. The importance and difficulties of moving from research to operations has already been raised several times in this conference and deserves considerably more attention. However, I would like to concentrate here, not on the broad transition issue but on the narrower and slightly different issue of how researchers themselves might think about and structure their activities to better position themselves (and their findings) for eventual application to space.

Human factors researchers, like other researchers, select their methods and approaches based on the demands of the questions to be answered. Some questions are best addressed in the highly controlled environment of the laboratory; others address contextual factors and must be studied in the field. Frequently, a variety of approaches is needed to fully understand the contributions of the various elements. Figure 6 lists a number of research approaches.

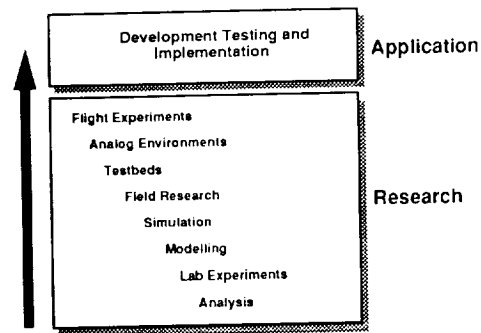


Figure 6 - Research Approaches

For the space human factors researcher the task is to plan his or her activities to "move" the research to where it can inform spaceflight. This means both understanding the aspect of human behavior being studied and understanding how environments might change this behavior. The former without the latter is unusable; the latter without the former is unsupportable. Taking one example, a phenomenon might be examined initially in the laboratory, modeled and verified for generalizability, and tested in the field. At this point, a controlled investigation in an analog environment or in space may be indicated. The specific progression of the research will change with the subject of investigation. However, in all cases the mental set of the researcher must include both building a solid scientific understanding and progressing towards the space application.

SOAR '91

It is not possible in any one conference to discuss all aspects of the NASA Space Human Factors program as outlined in general terms above. In this year's SOAR Conference, a small number of topics have been selected for inclusion in the Human Factors/Life Science track. The topics selected fit the NASA perspective in the following ways. The two sessions on Methods, Tools, and Analysis provide an opportunity to discuss and highlight recent advances in structural and performance models and their utility in understanding human performance in space. The Virtual Reality session focuses our interests on this new method of individually simulating a desired environment. Such simulation can be

almost dimensionless and could be utilized, for instance, in support of onboard training for a Mars mission. The Human/Machine Interaction session underscores the importance of the emerging field of crew systems and the need to understand the dynamics of these systems as applied to separated and highly autonomous crews. Although these topics define only a subset of the ongoing NASA program, they are important both in their own right and reflect a confluence of interest and activity in NASA and the Air Force.